CLAIMS

1. A piezoelectric ceramic composition comprising:

a phase comprising, as a main component, lead zirconate titanate having a perovskite structure; and

an Al-containing phase.

2. The piezoelectric ceramic composition according to claim 1, wherein:

said main component comprises Mn and Nb.

3. The piezoelectric ceramic composition according to claim 1, wherein:

said main component is represented by a composition formula of $Pb_{\alpha}[(Mn_{1/3}Nb_{2/3})_xTi_yZr_z]O_3$ (wherein $0.97 \leq \alpha \leq 1.01$, $0.04 \leq x \leq 0.16$, $0.48 \leq y \leq 0.58$, $0.32 \leq z \leq 0.41$).

4. The piezoelectric ceramic composition according to claim 1, wherein:

said Al-containing phase comprises Al_2O_3.

5. The piezoelectric ceramic composition according to claim 1, wherein:

said piezoelectric ceramic composition is composed of a sintered body comprising grains and grain boundaries exist between said grains; and

Al_2O_3 is contained in said grains and is precipitated in said grain boundaries.

6. The piezoelectric ceramic composition according to claim 1, wherein:

said piezoelectric ceramic composition comprises Al_2O_3 in an amount of 0.15 to 15.0 wt%.

7. The piezoelectric ceramic composition according to claim 1, wherein:

$|\Delta F_0|$ which is the absolute value of the rate of change in oscillation frequency F_0 thereof, before and after application of a thermal shock, is 0.10% or less; and

the three-point flexural strength σ_{b3} thereof is 160 N/mm^2 or more.

8. A piezoelectric ceramic composition comprising:

a main component represented by the formula of $Pb_\alpha[(Mn_{1/3}Nb_{2/3})_xTi_yZr_z]O_3$, wherein α, x, y and z fall within the ranges of $0.97 \le \alpha \le 1.01$, $0.04 \le x \le 0.16$, $0.48 \le y \le 0.58$ and $0.32 \le z \le 0.41$, respectively; and

as an additive, at least one element selected from the group consisting of Al, Ga, In, Ta and Sc in an amount of 0.01 to 15.0 wt% in terms of an oxide of each element.

9. The piezoelectric ceramic composition according to claim 8, wherein:

said piezoelectric ceramic composition has α, x, y and z of said main component falling within the range of $0.98 \le \alpha < 1.00$, $0.06 \le x \le 0.14$, $0.49 \le y \le 0.57$ and $0.33 \le z \le 0.40$,

respectively.

10. The piezoelectric ceramic composition according to claim 8, wherein:

said piezoelectric ceramic composition has α, x, y and z of said main component falling within the range of $0.99 \leq \alpha < 1.00$, $0.07 \leq x \leq 0.11$, $0.50 \leq y \leq 0.55$ and $0.34 \leq z \leq 0.39$, respectively.

11. The piezoelectric ceramic composition according to claim 8, wherein:

said piezoelectric ceramic composition comprises Al as said additive in an amount of 0.05 to 5.0 wt% in terms of Al_2O_3.

12. The piezoelectric ceramic composition according to claim 8, wherein:

said piezoelectric ceramic composition comprises Al as said additive in an amount of 0.15 to 1.5 wt% in terms of Al_2O_3.

13. The piezoelectric ceramic composition according to claim 8, wherein:

said piezoelectric ceramic composition comprises Si in an amount of 0.005 to 0.15 wt% in terms of SiO_2.

14. The piezoelectric ceramic composition according to claim 8, wherein:

the electric property Q_{max} ($Q_{max} = \tan\theta$: θ is a phase angle) thereof is 30 or more;

$|\Delta k_{15}|$ which is the absolute value of the rate of change in electromechanical coupling factor k_{15} thereof, before and after application of a thermal shock, is 4% or less;

$|\Delta F_0 (-40°C)|$ which is the absolute value of the rate of change in oscillation frequency F_0 thereof at -40°C, with reference to 20°C, is 0.4% or less; and

$|\Delta F_0 (85°C)|$ which is the absolute value of the rate of change in oscillation frequency F_0 thereof at 85°C, with reference to 20°C, is 0.4% or less.

15. A piezoelectric ceramic composition comprising a sintered body comprising; as a main component, a perovskite compound having mainly Pb, Zr, Ti, Mn and Nb; and as an additive, at least one element selected from the group consisting of Al, Ga, In, Ta and Sc, wherein:

the electric property Q_{max} ($Q_{max} = \tan\theta$: θ is a phase angle) thereof is 100 or more;

$|\Delta k_{15}|$ which is the absolute value of the rate of change in electromechanical coupling factor k_{15} thereof, before and after application of a thermal shock, is 2% or less;

$|\Delta F_0 (-40°C)|$ which is the absolute value of the rate of change in oscillation frequency F_0 at -40°C thereof, with reference to 20°C, is 0.2% or less; and

$|\Delta F_0 (85°C)|$ which is the absolute value of the rate of change in oscillation frequency F_0 at 85°C thereof, with reference to 20°C, is 0.2% or less.

16. The piezoelectric ceramic composition according to claim 15, wherein:

said sintered body comprises Al_2O_3.

17. The piezoelectric ceramic composition according to claim 15, wherein:

said sintered body comprises a main component represented by the formula of $Pb_\alpha[(Mn_{1/3}Nb_{2/3})_xTi_yZr_z]O_3$, wherein α, x, y and z fall within the range of $0.99 \leq \alpha < 1.00$, $0.07 \leq x \leq 0.14$, $0.50 \leq y \leq 0.55$ and $0.34 \leq z \leq 0.39$, respectively.